APPLICATION FOR UNITED STATES LETTERS PATENT

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TITLE: SEGMENTED COLD FORMED JOIST

SEGMENTED COLD FORMED JOIST

Field of Invention

This invention relates generally to a joist and particularly relates to floor and roof joists for building construction and more particularly to methods for producing concentric top chord bearing cold form joists for composite concrete and non-composite joist conditions for the construction industry.

Background of Invention

Joists are commonly used in the construction industry to span a distance and provide a surface for a floor, roof or the like. Joists can be comprised of a variety of materials including wood and metal.

Metal or steel joists can be constructed in an open web configuration, which generally consists of spaced apart upper and lower chord members which extend longitudinally thereof and are fastened together by a zig-zag web. Such open web joists are typically manufactured by hot-roll structural sections namely the upper and lower chord members and the webs. The webs typically can be comprised of hot-rolled steel rods, which are zig-zagged and welded to the upper and lower chords. The webs are open in the sense that there is a space between the rods longitudinally along the central web section that can receive utilities such as wires or air ducts that are installed by other trades.

Open web joists can be concentric, that is they are symmetric about the web in cross section, or eccentric.

The joist industry has introduced various types of composite concrete non-combustible floor and roof systems for the construction industry. Examples of composite joists can be found in U.S. Patent Nos. 5,941,035, 4,741,138, 4,454,695, U.S. Publication No. 2002/0046534 A1 and 2002/0069606 A1. A composite joist design permits the top chord member of a joist to be designed

with less steel in comparison with non-composite systems since the concrete slab when properly bonded to the upper steel joist acts as the top chord of the floor or roof system.

Generally speaking, for a structural joist member to be composite it must have means to mechanically interlock with the concrete to provide sheer bonding. It is generally difficult and costly to design steel and concrete composite floors using joists because legislation exists in various jurisdictions which relate to federal safety laws requiring that structural members cannot have objects extending above a structural floor member that will encumber the walking path of a worker.

Generally speaking the details for providing sheer bond capacity between the joist and the concrete in a composite joist are generally expensive to produce in the prior art.

Furthermore, camber (defined as a slight arch added to the joist) has been introduced into the open web joist technology to offset the deflection associated with dead loads such that only the live load deflection of the joist needs to be accounted for in designs of the joist. However large machines or jigs are needed to impart the camber to the chords of the joist were typically the web resists the cambering process.

Furthermore joists are erected in a “top chord bearing condition” where they hang passively vertical during and after erection from its top or upper chord at the support ends. Alternatively joists can be” bottom chord bearing” where the bottom chord supports the joist.

Moreover, hot-rolled open web joists are typically coated or finished with a primer that can be coloured grey or red. Steel joists manufacturers typically use large tanks of paint into which completed welded joist assemblies are dipped to receive a coating of primer paint. However, the process has become more expensive due to environmental considerations when using dipped tanks containing volatile solvents.

Furthermore open web joists technology is dependent on skilled labour and in many instances set the critical path schedule on many construction projects during busy construction season periods when skilled labour is in highest demand.

Joists can also be produced by cold-formed steel structural designs and have been used in floor and roof joists in the building construction trade for some time. However prior art cold form steel joists are widely used for wall and floor framing in residential homes and non-load bearing wall framing where the span of the joist is not excessive. The cold form technology presently has limitation in span lengths for floor and roof members to be widely used.

Unless cold form materials can be used in the thin applications, the use of these materials is cost prohibitive since hot-rolled pre-finished steel coil material typically used in forming comes in at much greater cost than the hot-rolled shapes used for the open web industry as described above. Furthermore, cold-formed joists presently used only provide limited span lengths and are not very cost efficient to provide for spans greater than 24 feet.

Joists produced by cold-forming from a single piece of sheet metal is predominately used for bottom chord bearing conditions and these members generally have an eccentric nature about the "Y" Axis. Other examples of cold rolled constructions are shown in U.S. Patent Publication Nos. 2002/0020138 A1 and 2003/0084637 A1.

Moreover other manufactures have introduced "top chord bearing" single stripped cold-formed floor joists such as Hambro D510 and Speed Floor which has end attachments that can be welded, bolted or screwed onto a single strip cold-formed section to provide a top chord bearing condition. However these provide only limited load capacity due to the nature of the localised connection to the cold-formed joist member. Accordingly cold-forming production has generally been applied to a single piece of sheet metal since it requires very little direct manpower to produce.

Many cold-forming manufactures provide holes longitudinally along the central web section that are sized to receive utilities for follow-up trades. Since cold-formed joists material can be pre-finished (i.e. the coils of galvanised steel can be galvanised or painted) the manufacturing process is less harmful to the worker and environment than the open web production described above.

Although cold-forming provides superior surface finishes and very little dependency on manpower to produce relative to the open web technology, current cold-forming technology does not satisfy the requirements to optimise material use throughout the length of the individual members of the joist. One of the disadvantages of continuous cold-forming from a single piece of sheet material resides in the fact that material use along the length of the individual members cannot be rationalised or optimised.

Accordingly a device and method of producing the device that can combine the beneficial attributes from each of the open web technology and cold-forming technology is desirable. It is also increasingly desirable to manufacture using cold-forming methods versus open-web welded methods as a means to reduce the need for labour shortages. Further, material optimisation is limited when cold-forming if the section is constant in weight throughout the length.

Also both open web and cold-form structures at times require bridging systems to stabilize the joist about the "Y" Axis. It is common practice to weld bridging in open web joists while cold-forming systems have bridging structures that commonly use screws for fastening.

Furthermore open web steel joists are traditionally assembled in a jig with a weld being applied at the juncture of the individual component parts; which prevents open web technology from using pre-finished materials as the welding process would damage the pre-finish. Furthermore, cold-formed joists are traditionally mechanically fastened which inherently helps prevent damage to the finished part.

It is an aspect of this invention to provide a joist comprised of at least one cold-formed elongated chord member, a segmented cold-form web, and fasteners for securing the web to the chord member. In one embodiment of the invention the web comprises a plurality of web members.

It is another aspect of this invention to provide a supporting surface defined by a plurality of joists, each of the joists comprising spaced cold-formed upper and lower metal chord members, a web comprising a plurality of web members intermediate the upper and lower chord member, and fasteners to fasten the web members to the upper and lower chords where the upper chords define a supporting surface.

It is a further aspect of this invention to provide a composite. floor system comprising a plurality of metal joists, with the joists having, an upper chord member formed from sheet metal to present a vertical and horizontal upper cord extension, a lower chord member formed from sheet metal to present a horizontal lower chord extension, a plurality of web segments fastened together to define a substantially vertically disposed web, and mechanical fasteners to fasten the web to the spaced upper and lower chords; a concrete slab disposed on the upper chords of the plurality of joists with the vertical extension of the upper chord embedded in the concrete slab to define the composite floor.

Another aspect of this invention resides in a method of producing a joist comprising the steps of; forming upper and lower chords from sheet metal, forming at least one web member from sheet metal, fastening the web between the upper and lower chord with mechanical fasteners.

These and other objects and features of the invention shall now be described in relation to the following drawings:

Brief Description of Drawings

Fig. **1** illustrates a prior art open web steel joist (OWSJ).

Fig. **2** illustrates a prior art cold-formed C-shaped joist.

Fig. **3** illustrates one embodiment of the invention.

Fig. **4** illustrates a segmented web.

Fig. **5** is a perspective view of the second embodiment of the invention showing a concentric or symmetrical cold-formed joist having a segmented web.

Fig. **6** is a side elevational view of Fig. 5.

Fig. **7** is a cross sectional view along the line 7-7 of Fig. 5.

Fig. **8** illustrates a side-view of a plurality of joists having bridging members.

Fig. **9** is a side view of a plurality of joists having crossed bridging members.

Fig. **10** is a perspective view of the symmetrical or concentric cold-formed joist to be used in a composite joist.

Fig. **11** is a side elevational view of Fig. 10.

Fig. **12** is a cross sectional view along the lines 12-12 of Fig. 10.

Fig. **13** is a side elevational view of a composite floor system having a plurality of joists.

Fig. **14** is a perspective view showing a top chord bearing condition of the joist.

Fig. **15** illustrates a perspective top chord extension condition.

Fig. **16** is a cross sectional view through line 16-16 of Fig. 6.

Fig. **17** is a cross sectional view along the line 17-17 of Fig. 6.

Fig. **18** is a partial side elevational view of a segmented web.

Fig. **19** is a partial top view of Fig. 18.

Fig. **20** is a top expanded view of region 20-20 shown in Fig. 18.

Fig. **21** is a partial side elevational view of the reinforcing member.

Fig. **22** is a partial view of Fig 21.

Fig. **23** is a partial top plan view of the reinforcing member.

Fig. **24** is a cross-sectional view another embodiment of the joist.

Fig. **25** is a cross-sectional view of another embodiment of the invention.

Fig. **26** is a cross sectional view of another embodiment of the invention.

Fig. **27** is a cross-sectional view of another embodiment of the invention.

Fig. **28** is a schematic view of a roll forming machine.

Fig. **29** is a partial perspective view of a reinforced chord.

Fig. **30** is a side elevational view of another embodiment of the invention.

Fig. **31** is a partial enlarged view of Fig 30.

Fig. **32** is a side elevational view of applications of the invention.

Fig .**33** is a chart showing man hours per ton vs joist span.

Fig. **34** is a chart showing percentage weight evaluation vs joist span.

Fig. **35** is another embodiment of the invention.

Fig. **36a** is a top plan view of the flap 82.

Fig. **36b** is a perspective view of a further reinforced flap.

Fig. **37** is a top plan view of a further reinforcing member.

Fig. **38** is another embodiment of the invention.

Fig. **39** is an end view of Fig. 38.

DETAILED DESCRIPTION OF THE INVENTION

In the description that follows, like parts are marked throughout the specification and the drawings with the same respective reference numbers. The drawings are not necessary to scale and in some instances proportions may have been exaggerated in order to more clearly depict certain features of the invention.

Fig. 1 illustrates a prior art open web joist construction **2** consisting of an upper chord assembly **4** spaced from a lower chord assembly **6**. The chords are joined together by a zig zag web **8** which is generally connected to the upper and lower chord assembly **6** by a number of means including welding or the like.

Fig. 2 illustrates a prior art cold formed joist construction **10** having a web portion **12** having a plurality of holes **14** disposed there through for receiving utility such as wire or the like.

Fig. 3 illustrates one embodiment of the invention which comprises an assembled joist **20** having a first or upper chord member **22** spaced from a second or lower chord member **24**. A web member **26** is also disclosed. The web member **26** is fastened to the upper and lower chord members **22** and **24** by fastening means **28** . The fastening means can comprise of a variety of fastening means such as bolts and nuts (not shown), welding, rivets **30** or spot clinch **32** (Fig. 7).

The upper chord member **22** can be produced from a sheet of sheet metal. The sheet metal can be formed in a concentric fashion shown in Fig. 7 where the upper and lower chord members **22** and **24** are symmetrically disposed about web **26** or in an eccentric fashion shown in Fig. 25.

In one embodiment the upper chord member **22** is formed or bent to present a substantially flat upper load bearing surface **34** which is formed as shown in Fig. 7 to present lower load bearing wings or extensions **36** and **38**. The upper load bearing surface **34** is in contact with the lower load bearing extensions **36** and **38** so as to produce a rigid and structurally solid member which is fastened together by the spot clinch **32**. The spot clinch process is conducted in the manner well known to those persons skilled in the art and generally consists of a mechanism which pushes material by a plunger (not shown) to present a mushroomed head **40** as shown so as to secure the members together.

The upper load bearing surface **34** and lower load bearing extensions **36** and **38** are disposed symmetrically about the web **26** which defines "Y" axis as shown in Fig. 7. Accordingly, the upper load bearing surface **34** in concert with the lower load bearing extension **36** on one side of the axis **27** defines a horizontal extension **42** while the upper load bearing surface **22** to the right of the Y axis **27** in concert with the lower load bearing extension **38** defines a horizontal extension **44** disposed to the right side of the axis **27**. The lower load bearing extensions **36** and **38** are bent to form to spaced apart web receiving tabs **46** and **48** as shown. The upper portion **50** of the web **26** includes a plurality of holes **52** which are adapted to receive the fastening means **28**. Fig, 7 shows a fastening means **28** comprising a rivet **30**.

The spot clinches **32** in combination with the cold-formed chords connect the two folded portions **34** and **36** and **38** and **44** to reduce the width to thickness ratio of the section to avoid local buckling. The spot clinch **32** in combination with the cold work forming increases the yield strength of the steel part.

As shown in Fig. 7 the lower chord **24** is similarly constructed by forming sheet metal to present a lower chord surface **54** bent so as to present lower chord extensions **56** and **58** symmetrically disposed about axis **27**. The lower chord **54** in combination with the lower chord extension **56** and **58** define lower chord horizontal extensions **60** and **62** symmetrically disposed about the web **26**. The lower chord extensions **56** and **58** present two spaced apart web receiving tabs **64** and **66** which are adapted to receive the lower portion **68** of the web **26**.

The web **26** can include a plurality of utility holes **72** which provide an access for utilities such as electrical wires, air ducts or the like. The holes **72** as shown are circular although any configuration can be produced including square holes or the like. Furthermore, the holes **72** can include a lip **74** as shown in Fig. 16. The holes **72** lighten the total weight of the joist **20** while the lip **74** adds rigidity to the web structure **26** particularly in the "Y" axis.

The web **26** also includes a plurality of stiffening means **80** to stiffen the rigidity of the web member **26**.

The stiffening means **80** comprises a first stiffening means **82** and a second stiffening means **84**. The first stiffening means **82** generally consists of the ends of the web **26** being bent to form a stiffening tab **82** which is disposed at approximately a 90 degree angle from the web **26**. The second stiffening means **84** generally consists of a hollow rib structure **86** as best illustrated in Fig. 21.

The hollow rib structure **86** can be produced by a variety of means and in one example is produced by a punch (not shown) which pushes the web material **26** to present the stiffening structure **84** .The stiffening structure has two spaced side walls **88** and **90** as well as upper and lower walls **92** and **94** and stiffening front

wall **96**. The stiffening front wall **96** has stiffening holes **98** which are adapted to receive bridging members **100** in a manner to be more fully particularized herein.

Furthermore, the web **26** can comprise of a plurality of web segments **104, 106** and **108** as shown in Fig. 4. Although only three segments are shown in Fig. 4 any number of segments can be used. Each of the web segments **104, 106** and **108** are adapted to be fastened to one another. In particular, the web segments **104, 106, 108** include a first stiffening means **82** which comprise of sheet metal flaps which are bent at substantially 90 degrees from the web material **26**. The first stiffening flaps **82** include a plurality of holes **110** which are adapted to receive fasteners such as rivets, nuts and bolts, or spot clinches to secure the plurality of web segments **104, 106,** and **108** together to form a web **26**. The web segments **104, 106,** and **108** also include second stiffening means **84**.

The web segments can either all have the same thickness or can have different selected thickness. For example the web segments can be thicker at the ends of the joist than segments in the middle of the joist since the load-bearing load is greater at the ends than in the middle.

The joist shown in Fig. 5 can include angled end members **140** to secure the ends of the lower chord **24** and upper chord **22**. Furthermore rigidifying members **150** may be added so as to present one end **152** fastened to the lower chord **24** and another end **154** fastened to the stiffening tab **82** as shown in Fig. 7.

A plurality of joists **20** partially shown at Figs. 8 and 9 can define a supporting surface **160** to support a platform **162** such as a roof floor or the like. Each of the joists **20** comprises of spaced cold-formed upper and lower chord members **22** and **24** and a web **26** intermediately upper and lower chord members **22** and **24**. Fasteners **28** are utilised to fasten the web to the upper and lower chords; where the upper chords **22** define the supporting surface.

A plurality of bridging members **170**0 may be used to connect adjacent joists **20** together as shown so as to stiffen the joist **20** in the "Y" axis. Parallel bridges **170**

may be used as shown in Fig. 8 along with criss-crossed bridges **172** that are appropriately fastened at **174** as shown in Fig. 9.

The bridge members **170** can comprise of L-shaped sheet metal. Bridging member **170** can be made from sheet material which is bent to produce a first surface **172** and a second surface **174**. The second surface **174** is slotted at **176** as shown and the width W of surface **174** is less than the depth D of the hole **98** to permit the end **178** of the bridging member **170** to be inserted into the hole **98** and then rotated so as to lock the edges of the slot **176** against the reinforcement face **96** adjacent the hole **98**. Criss-crossed bridging members **172** may then be added and fastened as shown in Fig. 9.

Figs. 12 and 13 illustrate another embodiment of the invention defining a composite floor. In particular, the upper chord **22** can be formed so as to present horizontal extensions **190** symmetrically disposed about the central web **26** and presents spaced apart vertical extensions **192** and **201** adapted to receive the top portion **50** of the web **26** to define a vertical extension **194**. A rivet **196** may be utilized to fasten the upper chord **22** to the web **26** as shown.

A deck **198** is adapted to rest on the top surface of the horizontal upper chord extensions **190** as shown in Figs. 12 and 13. A wire mesh **205** is added. Thereafter concrete **206** can be poured onto the deck **198** so as to produce a floor or ceiling. Since the vertical extensions **194** are embedded into the concrete **200**, a very solid composite floor system is produced. The vertical extension **194** can also include a generally horizontal concrete engaging extension **202** which runs along the length of the chord **22**. Since the horizontal concrete engaging extension **202** runs along the length L of the chord **22**, the possibility of snagging a worker's foot or pant trouser is minimized thereby adding to the safety feature of the joist prior to pouring of the concrete **206** over the deck **198**.

The shear bond between the extensions **194** and **202** and the concrete is increased by using rivets spot clinches **32** or the like to increase the surface area of contact.

Fig. 24 illustrates another embodiment of the invention which includes an upper cold-formed chord **22** fastened to a web **26** by fasteners **30**. In the embodiment shown on Fig. 25, the bottom chord **24** is formed so as to present one horizontal extension **250** which is doubled upon itself and hole clinched; while the other horizontal extension **252** presents a single section of sheet metal.

A further embodiment of the invention is shown in Fig. 25 where the lower chord member **24** is a bent extension of the web **26**.

Fig. 26 illustrates another embodiment of the invention where the upper chord **22** has a single layer of sheet metal which is bent to produce the horizontal extensions **42** and **44** spaced apart to accommodate the end **50** of web **26** so as to define an upper vertical extension **194** having a horizontal concrete engaging extension **202**. The horizontal concrete engaging extension **202** can include a plurality of hole clinches to further strengthen the bond between the concrete and the upper chord **22** and thereby increase the shear strength of the composite.

Fig. 27 illustrates a further embodiment of the invention whereby the lower chord **24** is a bent extension of the bottom of the web **26**.

Fig. 29 illustrates that a chord member can include a cold-formed reinforcing section **300** which consists of sheet metal that is formed so as to present a lower chord reinforcing section **302** and an upper chord reinforcing section **304** adapted to embrace a portion of one of the chords **22** and **24** as shown. Alternatively, the reinforcing section **300** may extend along the full length of the chord member **22** and **24** as desired. The reinforcing portion **300** may be utilized to as to increase the strength of the chord member **22** and **24** as a desired position. Generally speaking, the ends of the chord members **22** and **24** may be reinforced as this is where the maximum load bearing stress occurs.

The chord members **22** and **24** extend longitudinally along a Length thereof which presents a first portion **310** having a first thickness FT and a second portion **320** having a second thickness ST.

Fig. 14 illustrates that the ends **300** of the upper chord **22** can include support shoes **302**. The support shoes can be comprised of sheet metal which are bent to present horizontal support shoe member **304** and a vertical support shoe member **306** having a plurality of holes **308** aligned with holes presented at the ends **300** of upper chord member **22** so as to fasten the support shoe **302** thereto. The support shoe **302** can be utilized when the joist **20** is supported by the ends **300** of the upper chord member **22**. Reinforcing gussets **310** can be formed so as to add strength to the structure.

Fig. 15 illustrates a top chord extension condition whereby a support shoe **302** is spaced from the end **300** of the upper chord member **22** so as to present an extension **312** that can be utilized in a variety of conditions including that of manufacturing and eave structure.

Alternatively the joist **20** can be supported along the bottom chord **24** as shown in Fig. 30 in a bottom chord bearing condition. Fig. 30 illustrates a cold form composite joist **20** supported along the bottom chord **24**.

In particular the ends **400** of the joist are disposed within the lower stud wall **402** and upper stud wall **404** as shown. The lower stud wall **402** includes a stud wall track **406** which is generally a flat piece of sheet metal **408** bent at its ends so as to present a solid surface to the joist. The upper stud wall **402** includes a similar stud wall track **406**. The stud wall **402** and **404** also includes a floor joist track **412** adjacent the end **400** of joist **20**.

The cross-section of the joist **20** seen in Fig. 30 can have any number of cross sections as described in the context of the composite joist including that shown in Figure 12. The composite joist is constructed in the manner previously described. An erection clip **414** can be utilized so as to locate the joist **20** prior to pouring the concrete to produce the composite joist. In particular the erection clip **414** comprises a general J-shaped clip in cross-section which is secured to the bottom of the stud wall track **406** and extension **202**. Once the concrete is poured the composite cold formed steel joist is supported by the bottom chord 24 at the ends **400** of the joist **20**.

Fig. 35 illustrates another embodiment of the invention utilizing concentric cold-formed joists which are bottom chord supporting in a residential home.

In particular the joist **20** rests on a foundation **402** having a support **410**. The end **400** of the joist **20** includes a reinforced flap **82** which is further particularized in Fig. 36a and 36b. In particular the flap **82** is cut along cut lines **600, 602** and **604** so as to present portions **620** and **622**. In particular portions **620** and **622** are folded along fold lines **606** and **608**. Thereafter portions **620** and **622** are further folded along fold lines **621** and **623** so as to present wing portions **624** and **626** which are adapted to contact the lower surface of upper chord member **22** and lower surface of lower chord member **24** as best shown in Fig. 35. Fastening means may be utilized to fasten the reinforcing wings **624** and **626** to upper and lower chord members **22** and **24** so as to further rigidify and strengthen the joist **20**.

Wooden or metal backing plates **412** are also utilized as shown in Fig. 35. Wooden pieces **414** may also be utilized as shown. The upper chord **22** produces a support surface for supporting plywood **416** or the like.

Further reinforcing members **700** may be utilized which comprises an elongated section of sheet metal having web contacting portions **702** and rigidifying portions **704** extending generally perpendicular to the web contacting portions **702**. The ends of the rigidifying portions **704** are are bent at **706** and **708** and adapted to contact the upper chord **22** and lower chord **24** respectively. Furthermore fastening means may be utilized to fasten the rigidifying section **700** to web **26** and upper and lower chords **22** and **24.**

Moreover Fig. 38 illustrates another embodiment of a load bearing bottom chord utilizing the rigidifying structure **700** shown in Fig. 37.

Fig. 28 generally illustrates the method of producing the cold-formed joist. The upper chord **22** can be produced from unrolling a roll of sheet metal **112** along path **114** to a roll forming machine **116** such as sold by Samco machinery located

in Toronto, Canada. The roll forming machine **116** can include a station to flatten and cut a selected length of the upper chord member **22**. Similarly, the lower chord member **24** can be produced by unrolling a roll of sheet metal **118** and flattening same along a path **120** to a roll forming machine **116** and cut to the desired length. Furthermore, the web **26** can also be produced by unwinding a roll of sheet metal **122** and flattening same at flattening station **123**. A shear **125** can be used so as to shear the web member **26** to its desired length. Thereafter, the web **26** approaches stiffening section **128** so as to produce the first and second stiffening means **82** and **84** as described.

The shear **125** can be used to produce the plurality of segmented webs **104, 106** and **108**. Each web segment **104, 106, 108** can have the left hand and right hand stiffening flaps **82** produced by stiffening station **130** and **132**. An appropriate punch **133** is used to produce in the second stiffening means **84** as described above in a drawing operation.

The sheet metal at stations **112, 118** and **122** can be galvanized or painted as desired prior to the forming process. Furthermore the roll forming machine **116** includes punches to punch the appropriate holes **52** in the upper and lower chord members **22** and **24** so as to accommodate the appropriate fastening means **28**.

Alternatively the roll forming machine **116** can include apparatus to spot clinch **32** the members together.

Accordingly the joist fabricated herein can be coated with a variety of paint colours which are painted prior to fabrication so as to produce a variety of joists having different colours and avoiding the dip painting characteristic of open web joist construction.

The invention as described herein presents a number of advantages over the prior art. For example, many of the prior art joists included a cambering of the upper and lower chords **22** and **24** so as to present a slight arch to increase load bearing capabilities of the joist. Such prior art cambering techniques required working against the web during the cambering process. Applicant's invention on

the other hand presents an advantage since the upper and lower chord members **22** and **24** can be cambered separately. Once the upper and lower chord members **22** and **24** are cambered they can be attached to the web **26** as described. Since the web **26** is not part of the upper and lower chord members **22** and **24** during the cambering process there is less resistance to the cambering.

Furthermore, the composite joist as described herein exhibits excellent resistance to shear forces due to the presence of fastening means **30** and particularly when utilizing spot clinches.

The support structures described herein can be utilized either as floor joists **500** or roof joists **502** as shown in Fig. 32 whether for office, multi-residential, retail or warehouse facilities.

Furthermore Fig. 33 illustrates an example of a comparison between the number of man hours per ton to produce prior art composite open web steel joist (composite OWSJ), a prior art open web steel joist (OWSJ) and applicants concentric or symmetrically disposed cold formed joist (CCFJ) and a prior art C-shaped joist represented by Fig. 2. Savings can be experienced using the invention described herein.

Furthermore, Fig. 34 illustrates a comparison of a prior art OWSJ, prior art composite OWSJ, and a prior art C-shaped joist vs. the invention described herein between applicants concentric cold formed joist and segmented concentric cold formed joist in connection with performance as a percentage of weight of valuation.

Although the preferred embodiment as well as the operation and use have been specifically described in relation to the drawings, it should be understood that variations in the preferred embodiment could be achieved by a person skilled in the art without departing from the spirit of the invention as claimed herein.